HEADLAMP FOR VEHICLE

The present application claims foreign priority based on Japanese Patent Application No. 2003-097080, filed March 31, 2003, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vehicle headlamp that forms a light distribution pattern having a horizontal cutoff line by a reflecting optical system comprising a light source including a semiconductor light emitting unit.

2. Background of the Related Art

In a related art marker lamp for a vehicle, such as a tail lamp, a light emitting diode has often been used as a light source. For example, JP-A-2001-332104, the contents of which is incorporated herein by reference, discloses a marker lamp for a vehicle in which a plurality of lighting units using light emitting diodes as light sources are arranged.

In recent years, the luminance of the related art light emitting diode has been enhanced. Therefore, there is a growing tendency to employ the light emitting diode as the light source of a headlamp for a vehicle.

However, a large number of light emitting diodes have such a structure that an almost rectangular light emitting chip is covered with an almost hemispherical mold lens as described in the above-referenced JP-A-2001-332104. When the light emitting diode is employed as the light source of the vehicle headlamp, various related art problems occur.

For example, but not by way of limitation, in the related art vehicle headlamp, it is necessary to employ a structure in which a light distribution pattern having a horizontal cutoff line can be formed so as not to produce glare to a driver in an oncoming car. In that case, the light distribution pattern

is formed as the aggregate of the inverted image of a light source in a headlamp for a vehicle having a reflecting optical system that reflects a light emitted from the light source toward the front part of a lighting unit by a reflector.

At this time, the image of a light emitting chip is greatly deformed, depending on the position of a light incidence on the reflector by the convex lens action of a mold lens. Therefore, a horizontal cutoff line cannot be formed clearly. For this reason, there is a related art problem in that the generation of glare cannot be suppressed effectively.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a vehicle headlamp capable of effectively suppressing generation of glare when a light distribution pattern having a horizontal cutoff line is formed by a reflecting optical system that includes a light source having a semiconductor light emitting unit. However, the present invention need not address this object, or any other objects.

To achieve at least the foregoing object, the present invention provides a reflecting optical system that includes a vehicle headlamp constituted to form a light distribution pattern having a horizontal cutoff line by a first reflecting optical system comprising a first light source including a semiconductor light emitting unit in which an almost rectangular light emitting chip is covered with an almost hemispherical mold lens and a first reflector for reflecting a light emitted from the first light source toward a front part of a lighting unit. In the foregoing system, the first light source is provided such that the light emitting chip is turned in an almost horizontal direction with one side of the light emitting chip set almost horizontally, and the first reflecting optical system forms the horizontal cutoff line by selectively utilizing a light emitted

from the first light source and reflected by the first reflector which is reflected in a reflecting region positioned in an almost front direction of the light emitting chip.

The "light distribution pattern having a horizontal cutoff line" may be a so-called light distribution pattern for a low beam, and other light distribution patterns may be used.

The type of the "semiconductor light emitting unit" is not particularly restricted but a light emitting diode or a laser diode can be employed, for example but not by way of limitation.

While the "first light source" has the light emitting chip provided in the almost horizontal direction, the specific orientation of the almost horizontal direction is not particularly restricted, but may employ a destination toward the side of the lighting unit or an inclined destination to the side of the lighting unit in a longitudinal direction, for example but not by way of limitation.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view showing a headlamp for a vehicle according to an exemplary, non-limiting embodiment of the present invention,

Fig. 2 is a sectional view taken along a line II - II in Fig. 1 according to an exemplary, non-limiting embodiment of the present invention,

Fig. 3 is a perspective view showing a light distribution pattern for a low beam formed on a virtual vertical screen positioned 25 m away from a front of a lighting unit, with a light irradiation from the vehicle headlamp according to an exemplary, non-limiting embodiment of the present invention,

Fig. 4 is a view showing how a light emitting chip is observed when a light emitting diode constituting a first light source of the vehicle headlamp is observed from an outside according to an exemplary, non-limiting embodiment of the present

invention,

Fig. 5 is a view showing the image of the first light source and a horizontal cutoff line forming pattern formed on the virtual vertical screen by a light reflected from a reflecting region positioned in the almost front direction of the light emitting chip in a first reflector of the vehicle headlamp, according to an exemplary, non-limiting embodiment of the present invention, and

Fig. 6 is a view showing the image of a second light source and an oblique cutoff line forming pattern formed on the virtual vertical screen by a light reflected from a reflecting region positioned in the almost front direction of the light emitting chip in a second reflector of the vehicle headlamp according to an exemplary, non-limiting embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

An exemplary, non-limiting embodiment of the present invention will be described below with reference to the drawings.

Fig. 1 is a front view showing a headlamp 10 for a vehicle according to an exemplary, non-limiting embodiment of the present invention, and Fig. 2 is a sectional view taken along a line II - II in Fig. 1.

The headlamp 10 for a vehicle is a lighting unit that forms a light distribution pattern for a low beam, and includes a reflector unit 12 and a transparent cover 14 attached to an opening portion on the front end of the reflector unit 12.

The reflector unit 12 includes a first reflecting optical system 20 having a first light source 16 and a first reflector 18, and a second reflecting optical system 30 having a second light source 26 and a second reflector 28. Both of the first and second light sources 16 and 26 include light emitting diodes formed by covering rectangular light emitting chips 22 with

hemispherical mold lenses 24, and are supported by a common holder 32. Moreover, the first and second reflectors 18 and 28 are formed integrally.

The first light source 16 is provided such that the light emitting chip 22 is turned in a left and horizontal direction with one side of the light emitting chip 22 set horizontally. On the other hand, the second light source 26 is provided in such a manner that the light emitting chip 22 is turned in a downward inclined direction at about 15 degrees to a right and horizontal direction with one side of the light emitting chip 22 set horizontally.

A reflecting surface 18a of the first reflector 18 is provided with a plurality of reflecting units 18s by setting, as a central axis, an optical axis Ax1 extended in a longitudinal direction to pass through the center position of the surface of the light emitting chip 22 in the first light source 16 and using, as a reference plane, a paraboloid of revolution setting the center position of the surface of the light emitting chip 22 to be a focal point.

On the other hand, a reflecting surface 28a of the second reflector 28 is provided with a plurality of reflecting units 28s by setting, as a central axis, an optical axis Ax2 extended in a longitudinal direction to pass through the center position of the surface of the light emitting chip 22 in the second light source 26 and using, as a reference plane, a paraboloid of revolution setting the center position of the surface of the light emitting chip 22 to be a focal point.

Fig. 3 is a perspective view showing a light distribution pattern PL for a low beam formed on a virtual vertical screen 25m in front of a lighting unit with a light irradiated forward from the headlamp 10.

The light distribution pattern PL for a low beam is a left

light distribution pattern having horizontal and oblique cutoff lines CL1 and CL2 on an upper edge thereof. The light distribution pattern is formed as a synthetic light distribution pattern obtained by two light distribution patterns formed by means of the first and second reflecting optical systems 20 and 30.

In the low beam light distribution pattern PL, the position of an elbow point E at an intersection of both cutoff lines CL1 and CL2 is set downward by approximately 0.5 to 0.6 degree of H-V as a vanishing point in the front direction of the lighting unit, and a hot zone HZ as a region having a high luminous intensity is formed in a slightly leftward position with respect to the elbow point E.

In the light distribution pattern PL for a low beam, a horizontal cutoff line forming pattern Pa for forming the horizontal cutoff line CL1 is formed by a light reflected from a reflecting region Za positioned substantially in front of the light emitting chip 22 of the first light source 16 in the reflecting surface 18a of the first reflector 18. This is shown more specifically in FIG. 2.

Horizontal cutoff line reinforcing patterns Pb and Pc for reinforcing the horizontal cutoff line forming pattern Pa are formed by a light reflected from a reflecting region Zb positioned on an outer peripheral side of the reflecting region Za, and a light reflected from a reflecting region Zc positioned on an inner peripheral side thereof.

In the light distribution pattern PL for a low beam, an oblique cutoff line forming pattern Pd for forming the oblique cutoff line CL2 is formed by a light reflected from a reflecting region Zd positioned substantially in front of the light emitting chip 22 of the second light source 26 in the reflecting plane 28a of the second reflector 28. Oblique cutoff line reinforcing patterns Pe and Pf for reinforcing the oblique cutoff line forming

pattern Pd are formed by a light reflected from a reflecting region Ze positioned on an outer peripheral side of the reflecting region Zd and a light reflected from a reflecting region Zf positioned on an inner peripheral side thereof.

Portions other than the oblique cutoff line forming patterns Pa and Pd and the oblique cutoff line reinforcing patterns Pb, Pc, Pe and Pf in the light distribution pattern PL for a low beam are formed by lights reflected from regions other than the reflecting regions Za, Zb and Zc on the reflecting surface 18a and regions other than the reflecting regions Zd, Ze and Zf on the reflecting surface 28a.

As described above, in the first and second reflecting optical systems 20 and 30, the horizontal cutoff line CL1 and the oblique cutoff line CL2 are formed by selectively utilizing the lights reflected from the first and second reflectors 18 and 28, which are reflected in the reflecting regions Za and Zd positioned substantially in front of the light emitting chips 22 of the first and second light sources 16 and 26. The foregoing occurs for at least the following reasons.

As shown in Fig. 4(a), when the light emitting diode constituting the first light source 16 is observed from the outside, the light emitting chip 22 is seen enlargingly by the convex lens action of the mold lens 24. At this time, the shape of the light emitting chip 22 appears distorted greatly depending on a direction of observation.

More specifically, in Fig. 4(b), the light emitting chip 22 originally having a shape shown by a two-dotted chain line appears enlarged as shown by a solid line. In other words, when the first light source 16 is observed in a front direction, the light emitting chip 22 is seen with an almost rectangular shape maintained as seen in a direction of an arrow A in Figs. 4(a)-(b). When the observation is carried out in a direction substantially

shifted from the front direction, the light emitting chip 22 appears deformed in a substantially trapezoidal shape, as seen in a direction of an arrow B or arrow C in Figs. 4(a)-(b). In that case, the shape of the light emitting chip 22 can be regarded to be almost rectangular within a range of an angle θ around the front direction of the light emitting chip 22. The angle θ has a value of approximately 50 degrees.

As shown in Fig. 2, a region positioned within a range of the angle θ on the reflecting surface 18a of the first reflector 18 is set to be the reflecting region Za. Furthermore, a region positioned within a range of the angle θ on the reflecting surface 28a of the second reflector 28 is set as the reflecting region Zd.

The image of the first light source 16 is formed as an inverted image on the virtual vertical screen by the light reflected from the first reflector 18. At this time, if the reflecting surface 18a is a paraboloid of revolution, images Ia, Ib and Ic of the first light source 16 formed by the lights reflected from the reflecting regions Za, Zb and Zc have shapes obtained by rotating, by 180 degrees, the shape of the light emitting chip 22, which is shown in the solid line of Fig. 4(b). This effect is shown in Fig. 5.

In other words, the image Ia formed by the light reflected from the reflecting region Za becomes almost rectangular, and the images Ib and Ic formed by the lights reflected from the reflecting regions Zb and Zc become almost trapezoidal. In that case, the image Ib formed by the light reflected from the reflecting region Zb is smaller than the image Ic formed by the light reflected from the reflecting region Zc, depending on a difference in a distance from the light emitting chip 22 to each of the reflecting regions Za, Zb and Zc.

The images Ia, Ib and Ic of the first light source 16 are actually formed as the horizontal cutoff line forming pattern Pa and the horizontal cutoff line reinforcing patterns Pb and Pc by the deflecting and diffusing functions of the reflecting units 18s formed on the reflecting surface 18a of the first reflector 18.

In that case, the horizontal cutoff line forming pattern Pa is formed by downwardly deflecting the image Ia of the reflecting region Za to a position in which an upper edge thereof is level with the horizontal cutoff line CL1, and carrying out deflection and diffusion in a horizontal direction. At this time, the image Ia takes an almost rectangular shape and the upper edge thereof is extended in an almost horizontal direction. Also in the horizontal cutoff line forming pattern Pa, the upper edge has a high contrast ratio. Consequently, it is possible to obtain the clear horizontal cutoff line CL1.

Moreover, the horizontal cutoff line reinforcing patterns Pb and Pc are formed by downward deflecting the images Ib and Ic of the reflecting regions Zb and Zc to a position in which they are hidden under the horizontal cutoff line CL1, and carrying out deflection and diffusion in a horizontal direction. At this time, the images Ib and Ic take substantially trapezoidal shapes and have upper edges that extend obliquely. In the horizontal cutoff line reinforcing patterns Pb and Pc, the upper edges do not have high contrast ratios. Since the patterns Pb and Pc are hidden under the horizontal cutoff line CL1, however, glare generation can be prevented. By the horizontal cutoff line reinforcing patterns Pb and Pc, it is possible to maintain a brightness under the horizontal cutoff line forming pattern Pa and on both sides in the horizontal direction.

On the other hand, the image of the second light source 26 is formed as an inverted image on the virtual vertical screen

by the light reflected from the second reflector 28. If the reflecting surface 28a is a paraboloid of revolution, images Id, Ie and If of the second light source 26 formed by the lights reflected from the reflecting regions Zd, Ze and Zf have shapes obtained by rotating, by 180 degrees, the shape of the light emitting chip 22 shown in the solid line of Fig. 4(b) in an inclination state of about 15 degrees, as shown in Fig. 6.

In other words, the image Id formed by the light reflected from the reflecting region Zd becomes substantially rectangular, and the images Ie and If formed by the lights reflected from the reflecting regions Ze and Zf become substantially trapezoidal. In that case, the image Ie formed by the light reflected from the reflecting region Ze is smaller than the image If formed by the light reflected from the reflecting region Zf depending on a difference in a distance from the light emitting chip 22 to each of the reflecting regions Zd, Ze and Zf.

The images Id, Ie and If of the second light source 26 are formed as the oblique cutoff line forming pattern Pd and the oblique cutoff line reinforcing patterns Pe and Pf by the deflecting and diffusing functions of the reflecting units 28s formed on the reflecting surface 28a of the second reflector 28.

In that case, the oblique cutoff line forming pattern Pd is formed by downward deflecting the image Id of the reflecting region Zd to a position in which an upper edge thereof is on the level with the oblique cutoff line CL2 and carrying out deflection and diffusion in a direction which is inclined by about 15 degrees with respect to a horizontal direction. At this time, the image Id takes a substantially rectangular shape and the upper edge thereof is extended in a direction which is inclined by approximately 15 degrees with respect to the horizontal direction. Also in the oblique cutoff line forming

pattern Pd, therefore, the upper edge has a high contrast ratio. Consequently, it is possible to obtain the clear oblique cutoff line CL2.

Moreover, the oblique cutoff line reinforcing patterns Pe and Pf are formed by downward deflecting the images Ie and If of the reflecting regions Ze and Zf to a position in which they are hidden under the oblique cutoff line CL2 and carrying out deflection and diffusion in a direction which is inclined by about 15 degrees with respect to the horizontal direction. At this time, the images Ie and If take substantially shapes and have upper edges extended in a different direction from the oblique cutoff line CL2. In the oblique cutoff line reinforcing patterns Pe and Pf, the upper edges do not have high contrast ratios. Since the patterns Pe and Pf are hidden under the oblique cutoff line CL2, however, glare generation can be prevented. By the oblique cutoff line reinforcing patterns Pe and Pf, it is possible to maintain a brightness under the oblique cutoff line forming pattern Pd and on both sides in the oblique direction.

As described above, the headlamp 10 for a vehicle according to the exemplary, non-limiting embodiment is constituted to form a light distribution pattern having the horizontal cutoff line CL1 by the first reflecting optical system 20 comprising the first light source 16 including the light emitting diode in which the rectangular light emitting chip 22 is covered with the hemispherical mold lens 24 and the first reflector 18 for reflecting a light emitted from the first light source 16 toward the front part of the lighting unit. The first light source 16 is provided such that the light emitting chip 22 is turned in the horizontal direction with one side of the light emitting chip 22 set almost horizontally, and furthermore, the first reflecting optical system 20 is constituted to form the horizontal cutoff line CL1 by selectively utilizing a light

emitted from the first light source 16 and reflected by the first reflector 18 which is reflected in the reflecting region Za positioned in the almost front direction of the light emitting chip 22. Therefore, at least the following functions and advantages can be obtained.

The present invention has various advantages. For example, but not by way of limitation, the light emitting chip 22 of the first light source 16 is formed rectangularly and turned in the horizontal direction with the side set horizontally. Therefore, the inverted image of the first light source 16 formed on the virtual vertical screen provided in the forward part of the lighting unit by the light reflected in the reflecting region Za positioned in the almost front direction of the light emitting chip 22 becomes the almost rectangular image Ia having an upper edge extended almost horizontally. In the exemplary, non-limiting embodiment, the almost rectangular image Ia is utilized to form the horizontal cutoff line forming pattern Pa. Consequently, it is possible to obtain the clear horizontal cutoff line CL1. Thus, the generation of glare can be suppressed effectively.

In the embodiment, a light distribution pattern having the oblique cutoff line CL2 rising obliquely from the horizontal cutoff line CL1 at about15 degrees is formed by the second reflecting optical system 30 comprising the second light source 26 including the light emitting diode in which the rectangular light emitting chip 22 is covered with the hemispherical mold lens 24 and the second reflector 28 for reflecting a light emitted from the second light source 26 toward the front part of the lighting unit. In that case, the second light source 26 is provided such that the light emitting chip 22 is turned in a direction which is downward inclined at about 15 degrees with respect to the horizontal direction with one side of the light

emitting chip 22 set horizontally. Furthermore, the second reflecting optical system 30 forms the oblique cutoff line CL2 by selectively utilizing a light emitted from the second light source 26 and reflected by the second reflector 28 which is reflected in the reflecting region Zd positioned in the almost front direction of the light emitting chip 22. Therefore, the following functions and advantages can be obtained.

More specifically, the light emitting chip 22 of the second light source 26 is formed rectangularly and is turned in the direction which is downward inclined at about 15 degrees with respect to the horizontal direction with the side set horizontally. Therefore, the inverted image of the second light source 26 which is formed on the virtual vertical screen provided in the forward part of the lighting unit by the light reflected in the reflecting region Zd positioned in the almost front direction of the light emitting chip 22 becomes the almost rectangular image Id having an upper edge rising obliquely at about 15 degrees with respect to the horizontal direction. In the embodiment, the almost rectangular image Id is utilized to form the oblique cutoff line forming pattern Pd. Consequently, it is possible to obtain the clear oblique cutoff line CL2. Thus, the distant visibility of a self-car driver can be maintained, and furthermore, the generation of glare can be suppressed effectively.

In the embodiment, furthermore, the first reflector 18 and the second reflector 28 are formed integrally. Therefore, the positional relationship between the horizontal cutoff line CL1 and the oblique cutoff line CL2 can be decided. Moreover, the aiming regulation of the headlamp 10 for a vehicle can be collectively carried out for both of the first and second reflecting optical systems 20 and 30.

In the exemplary, non-limiting embodiment, when the

horizontal cutoff line forming pattern Pa and the oblique cutoff line forming pattern Pd are formed, the image Ia of the reflecting region Za and the image Id of the reflecting region Zd are deflected downward to the position in which the upper edges thereof are level with the horizontal cutoff line CL1 and the oblique cutoff line CL2. The optical axes Ax1 and Ax2 may be previously set downward corresponding to the downward deflection. In such a case, the concavo-convex amount of each of the reflecting units 18s and 28s can be reduced. Consequently, it is possible to easily form the reflecting surfaces 18a and 28a.

While the lights emitted from the first and second light sources 16 and 26 which are reflected by the first and second reflectors 18 and 28 are subjected to deflecting and diffusing control by the reflecting units 18s and 28s formed on the reflecting surfaces 18a and 28a in the embodiment, it is also possible to employ a structure in which a plurality of lens units is formed on the transparent cover 14 and the deflecting and diffusing control is carried out by refraction.

While the headlamp 10 for a vehicle comprises one first reflecting optical system 20 and one second reflecting optical system 30 in the embodiment, it is also possible to employ a structure in which the first and second reflecting optical systems 20 and 30 are provided in plural sets. In such a case, the light distribution pattern PL for a low beam can have a higher brightness.

It will be apparent to those skilled in the art that various modifications and variations can be made to the described preferred embodiments of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover all modifications and variations of this invention consistent with the scope of the appended claims and their equivalents.